

Use of information technology for traceability and quality control: Case study in a Brazilian winery

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Abstract. Food safety and quality are current demands from consumers and markets, which ends up being reflected in the wine sector and throughout its chain. However, they can pose operational challenges, especially for small or medium-sized wineries. This study aims to develop the traceability of the grape used in wine production supported by information technology in a winery situated in Garibaldi, RS, Brazil. The study was carried out in three phases: protocol development, implementation of an information system and evaluation of the results, identifying opportunities and barriers. A standard protocol for the grapes traceability was developed, considering data from grape cultivation, delivered grape quality assessment and grape processing control parameters until bottling. Demetra software was deployed, developed by Elysios. The implementation of traceability and the information system will be a step towards obtaining international certifications. The study contributes to bringing international standards of food safety and quality to the Brazilian context. In this sense, the study contributes to expanding the applied knowledge on the field and to support professionals and wineries in the development of strategies for the implementation of traceability systems.

1 Introduction

Digital transformation is a process that accelerated after COVID-19 and has been affecting all industries and society more broadly, bringing opportunities and challenges. The use of technologies such as artificial intelligence, blockchain, automation or IoT can be an important vector of competitiveness in an increasingly globalised market, with a demanding and changing consumer, but which has stable prices and growing production, i.e, growing competition. Among the opportunities, the relationship tools with consumers and the consolidation of e-commerce as a relevant channel, in terms of volume and frequency, can be highlighted. Important consultancy in the area, in a follow-up of the markets and trends, pointed e-commerce as a mainstream channel for China and a meaningful channel in key markets, highlighting US, UK and Germany [1].

From operations' point of view, digital tools can contribute from process automation to greater control of production and logistics operations. Technologies allow greater access to data in decision-making, in a process known as data-driven. Digital platform and operational

ackbone are among the pillars of digital transformation [2].

Innovation is important for the industry's growth and competitiveness. The Covid-19 pandemic had changed the advance of traditional models of technological innovation. The current sanitary situation makes it more urgent to find more innovative ways of supporting the advancement of the wine industry, nowadays, limited only to the promotion of products and services of the wine farms and companies [3].

Quality control evolution may be cited in programs of Good Manufacturing Practices (GMP's), the HACCP (Hazard Analysis and Critical Control Points), and the ISO2000 certification, BRC (British Retail Consortium) and IFS (International Featured Standards). BRC and IFS are part of the GFSI (Global Food Safety Initiative), which is a non-profit global initiative that aims to support food safety management systems [4].

The standards of food safety programs that are part of the GFSI initiative have changed over time, including the adoption of continuous development measures to prevent intentional infection in the production chain [5].

The need to provide consumers with safer products that meet the demands of a globalised market includes the production of beverages, based on preventive measures in the manufacturing process [6]. It is evident that the national and international food and beverage market has been demanding more and more quality control and consequent traceability of the raw materials used in its production processes.

Digital transformation can also contribute in terms of quality control, food safety and environmental sustainability [7]. Food system traceability, for example, can be enhanced using big data analytics based methods [7], while blockchain technology can contribute to wine sustainability certification in terms of traceability reliability along the supply chain [8].

While digital tools have enormous potential, there is a relative consensus that digital transformation should be part of a broader business strategy, aligned with competitive priorities [9-11]. In this context, food safety and quality are current demands from consumers and markets, which ends up being reflected in the wine sector and throughout its chain. However, they can pose operational challenges, especially for small or medium-sized wineries. Based on this issue, this study aims to develop the traceability of the grape used in wine

production supported by information technology in a winery situated in Garibaldi, RS, Brazil.

Viticulture is an important source of income in several Brazilian regions, and in these, there are small, medium and large viticultural properties, and this activity has contributed to the sustainability of viticulture in the generation of jobs and income. The main Brazilian area with concentration of vines is the southern region, representing 73.12% of the Brazilian area in 2020. In this region, Rio Grande do Sul is the main producing state with 62.51% of the national area. Of the grapes destined for processing, the largest volume is for the production of juices and table and fine wines [12].

According to IBGE, Brazilian Institute of Geography and Statistics, in 2021 there were 1.748.197 tones of grape in the country, in 75.622 acres. Being the Rio Grande do Sul (RS) the biggest producer, with 951.254 tons, in 46.295 acres. In RS there were 2023 grape production properties in 2017 [13].

The study aims to contribute to bringing international standards of food safety and quality to the Brazilian context. In this sense, the study contributes to support professionals and wineries in the development of strategies for the implementation of traceability systems.

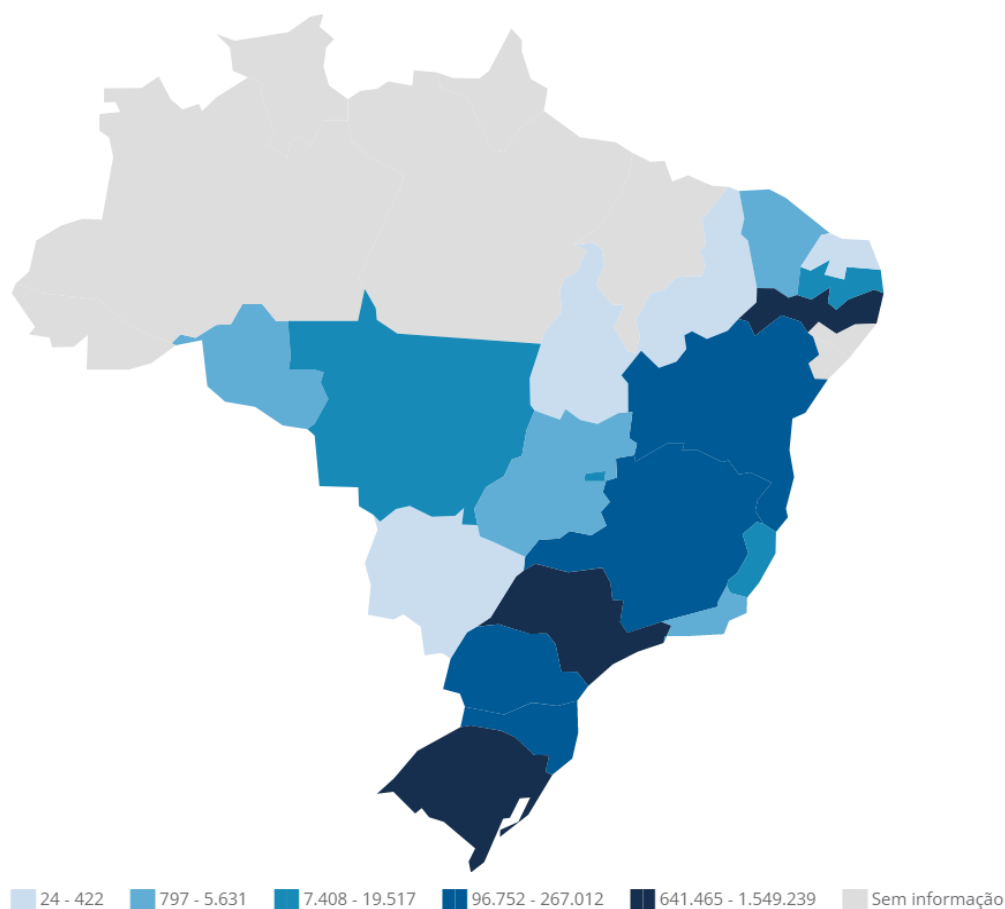


Figure 1. Production grape value (thousand reais), according to brazilian estate [13].

2 Background

2.1 Traceability

Current studies demonstrate that international buyers are imposing stricter conditions on suppliers in the supply chain, with more demanding standards than those of the country itself. The implementation of a traceability system is one of these requirements, as it is a significant factor in offering safe and healthy food [7].

Since the grape is the main raw material for wine production, its production control is indispensable for controlling the traceability of products and their consequent entry into new markets. In this sense, agricultural production, when conducted under the necessary hygienic conditions, reduces the possibility of dangers that may affect the hygiene and safety conditions of production and its derivatives [8].

Globally, until today, traceability frameworks developed for wine were most of them for track wines produced in regions with protected designations, or also, to control heavy metals and pesticide residues.

For the OIV - International Organization of Vine and Wine (2020), the implementation of food safety systems in the management system, going beyond sanitary standards, is a way of guaranteeing and expanding towards sustainable viticulture, with traceability among the tools for that [14].

The wine industry has put forward a growth path to better implementation of sustainable practices in the overall production and distribution process. So, the wine industry has a high number of sustainability programs, certification processes, and sustainability standards [8,16,17].

Generally, wine sustainability programs are promoted by governments or by wine industry associations. It is necessary to have a private label to certify that the wine or winery complies with the sustainability standard. Certification only comes after verification of accordance with the program's technical specifications [17].

2.2 Quality in Brazilian winery industries

In Brazil, the production of wines and beverages is supervised by the Ministry of Agriculture, Livestock and Food Supply (MAPA), through law n° 7678, of November 8, 1988, and complemented by Identity and

Quality Standards - PIQs established in specific Normative Instructions [18].

There are registers of all grape and wine movements inside the winery, but there isn't a traceability fast tool for products that are in the marketplace.

3 Materials and methods

The project is being developed in a medium sized Brazilian winery, located at Garibaldi - Rio Grande do Sul. The grape production occurs in own vineyards and with partners.

3.1 Planning grape traceability framework

There were recognized processes in the wine supply chain range from the harvest of the grapes in the vineyard to the distribution of the final products. It was necessary to recognize the process and the risks in each step, through reviewing the feedstock risk analysis existing in the winery, and according to: wine raw materials management process (harvest and the receipt of the wine products), wine production management (production of the must to bottling and packaging), wine order management process (preparation of finished products and the execution of orders) and wine distribution process [19].

These verification are described in PIQs, standard operational procedure and HACCP (Hazard analysis and critical control points).

3.2 Information system and batch control

All treatments and other vine managements were registered in Demetra software deployment, developed by Elysio. It's a management platform that integrates the grape producer with the company's technical team. In the case of grape partner producers, the registers were taken at vintage and later added to the software. All this data information was saved and linked to quality evaluation of grape receive and to tanks traceability spreadsheet.

All the final spreadsheets are finished when the wine bottling occurs. And at this moment, a new bottling code is created, that is called batch control. With this code it's possible to discover what was the vineyard of the product in recall situations.



Figure 2. Batch control creation process.

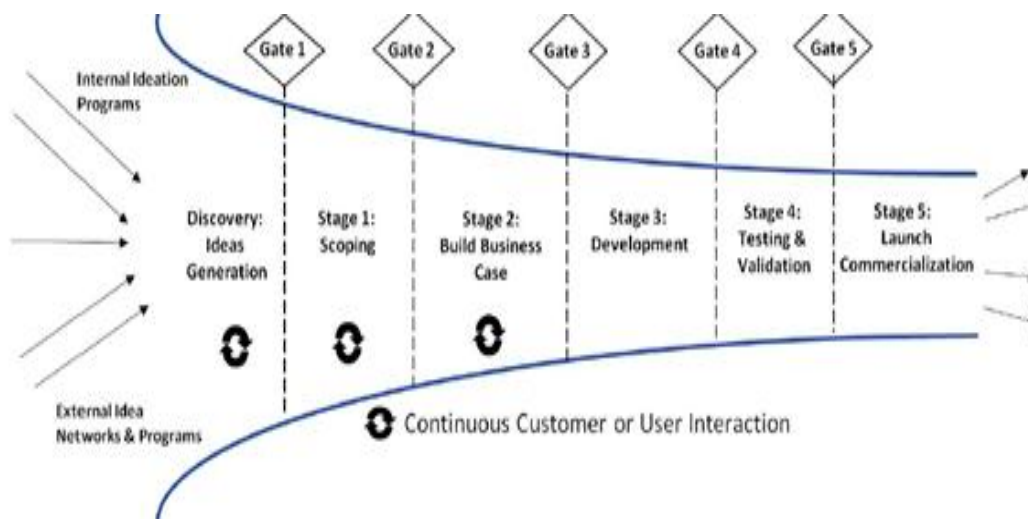


Figure 3. Tradicional Stage Gate [20].

3.3 Viability analysis

The international quality certification is a process which requires investments that need to be justified in a company. So, during this project, this was verified by direction with the technical and quality team.

The methodology used was Stage Gate (Fig. 3), a tool for value business creation, to quickly and profitably transform new ideas into new products [20]. The criteria considered in this work were described by Cooper, 1990: severity of demand, degree of innovation, viability and strategic alignment [21].

4 Results and products

Results obtained up to this moment are presented in Figs. 4 and 5.

From the Demetra Software, it was possible to register 14 vineyards, with 9,4 acres. The grape varieties Merlot, Lorena, Lambrusco, Chardonnay, Glera, Moscato Branco, Moscato Giallo and Pinot Noir also were registered. Likewise, records of treatments and management made during the year in the vineyards also were stored.

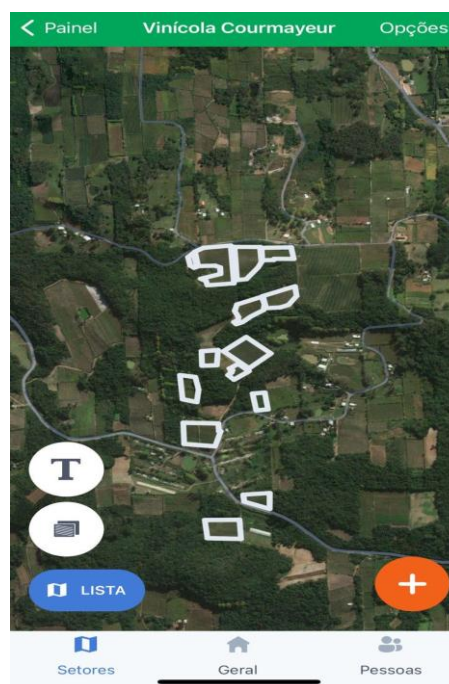


Figure 4. Vineyards map in Demetra Software.

DATA	TIPO	TRETNHES	LOCALIZAÇÃO	STATUS	OPÇÕES
09/12/2022	Manejo	Desponta	Vinícola Courmayeur Lavoura	Concluída	⋮
09/12/2022	Manejo	Desponta	Vinícola Courmayeur Lavoura Lavoura	Concluída	⋮
03/12/2022	Manejo	Desfolha manual	Vinícola Courmayeur Lavoura Espalçada	Concluída	⋮
03/12/2022	Manejo	Desponta	Vinícola Courmayeur Processo de Moino (Quarta 2)	Concluída	⋮
02/12/2022	Manejo	Desfolha manual	Vinícola Courmayeur Lavoura Espalçada	Concluída	⋮
02/12/2022	Manejo	Destrota	Vinícola Courmayeur Moino Galo	Concluída	⋮
01/12/2022	Manejo	Desfolha manual	Vinícola Courmayeur Lavoura Espalçada	Concluída	⋮
30/11/2022	Aplicação	Kocide WDG Bioactive, Manzate WG Inseticida, Fungicida	Vinícola Courmayeur Moino	Concluída	⋮
30/11/2022	Aplicação	Kocide WDG Bioactive, Manzate WG Inseticida, Fungicida	Vinícola Courmayeur Lavoura Lavoura	Concluída	⋮
30/11/2022	Aplicação	Kocide WDG Bioactive, Manzate WG Inseticida, Fungicida	Vinícola Courmayeur Lavoura Espalçada	Concluída	⋮
29/11/2022	Aplicação	Sulfato de cobre Fertilizante Mineral	Vinícola Courmayeur Moino Galo	Concluída	⋮
29/11/2022	Aplicação	Sulfato de cobre Fertilizante Mineral	Vinícola Courmayeur Processo (Quarta 1)	Concluída	⋮

Figure 5. Records of treatments and managements made during the year in the vineyards of Demetra Software.

Another stage of this work will be to determine patterns of phytosanitary conditions of the grapes when they enter the winery in order to establish compliance with quality requirements. The records will be made in specific sheets containing the conditions at the time of the raw material. Finally, a worksheet will be created to control the number of grapes received in non-compliance with the established standards. From this data, records will be created of batches of finished products produced

annually, in order to fill the production management system with codes created and registered on the products at each bottling. After implementing these procedures, the process of integration between all processes must take place between those responsible for each activity of the company so that the data will be synchronised.

As a last step, the feasibility of certification in an international protocol will be verified using the Stage-Gate process (21), with some modifications.

Table 1. Activities made in each Stage Gate analysis.

St.	Topic	How
1	International Certification planning	International quality certification clients demand.
2	Survey needs	PIQs, standard operational procedure and HACCP.
3	Certification type definition	There are 3 certification options (IFS Food, BRC and FSSC22000). All the certification structures have to be studied to analyse what is the best option for the winery.
4	Costs and clients	Direction and technical team had listed the costs involved in certification. Together this, the commercial team listed the invoicing with the clients and already have the quality control demand. There were listed new possible clients for the future.
5	Product Pricing	With the costs calculated, a new wine price was defined and proposed to the actual clients. This value was accepted by them.

The challenge applied to this project deals with certification with quality programs, since it is not common.

Table 2. Opportunities and barriers.

Opportunities	Barriers
QRcode traceability implement	Low reliability of producers information
Work with precision viticulture	Failure in digital registers
Market growth	Failure team communication

A good suggestion is to implement a QRcode traceability in each product, like in others food and drinks. In the same way, this code can be linked with vineyards that already have precision agriculture.

This profile is endorsed by the legislation, which is proposed for application in the food industry, and not in the wine industries in general.

During the process, some mistakes could have occurred, like barriers described in Table 2.

5 Conclusion

Having achieved the objective, Brazilian wine gains greater credibility and consequent growth in the market and demand. The local wine sector becomes stronger, from small grape producers to large wine and sparkling wine producers. With a grape traceability system in place, the winery will need to be more careful in selecting grape suppliers, grape producers will need to be more careful in cultivation and, therefore, there will be more security offered to end consumers.

This medium-complexity management and quality system can be used in any company that produces beverages derived from grapes, that is, any winery or company that produces wines, sparkling wines and juices. innovation for the sector. The framework that was created in this project is a tool that can be used by little and medium sized wineries. It's a good way to start the traceability work and can help in wine production quality control growth.

This work comes together with modern-day globalization. Bioinformatics and other digital informations are now intensely present in wine industry [20].

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